FLIGHT OF STS-3 WITH ASTRONAUTS COLONEL JACK ROBERT LOUSMA AND COLONEL CHARLES G. FULLERTON

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FLIGHT OF STS-3 WITH ASTRONAUTS COL. JACK ROBERT LOUSMA AND COL. CHARLES G. FULLERTON

WEDNESDAY, APRIL 21, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C.

The committee met, pursuant to call, at 10:15 a.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the committee) presiding.

Mr. FUQUA. The committee will be in order.

Without objection, permission to photograph and televise the proceedings will be granted.

This morning the members of the Science and Technology Committee are honored with the opportunity to welcome two of America's latest heroes, Marine Col. Jack R. Lousma and Air Force Col. C. Gordon Fullerton.

Commander Lousma was on the second crew of the Skylab space station for 59 days in 1973.

Colonel Fullerton distinguished himself when teamed with Astronaut Fred Haise on three of the five approach and landing flights of the Space Shuttle orbiter *Enterprise* in 1977.

The successful launch and landing of the STS-3 mission continued the engineering shakedown of the Space Shuttle system and among the many accomplishments successfully measured the thermal responses of the spacecraft during long periods of exposure to the Sun.

The mission also accomplished some other firsts, including the grappling and hoisting of the instrument package from the payload bay into the space environment and returning it to the cannister.

Gentlemen, each successive flight in this series verifies the Space Shuttle's capability and flexibility to do the job for which it was designed—haul heavy payloads into and out of Earth orbit with a reusable vehicle.

We look forward to your testimony and the success of your onboard experiments and also anything new that you have learned about fixing television cameras, et cetera.

The astronauts are accompanied today by Jim Beggs, administrator of NASA, who can take pride in this successful mission under his leadership and, to you, Jim, we want to congratulate you and wish you continued success.

Before commencing with the testimony of our distinguished witnesses, I would like to recognize two very important people that

play, I think, an equally significant role in any type of credit that they may receive. I would like at this time to please stand, Mrs. Gratia Lousma, and also Mrs. Marie Fullerton. It is a pleasure to have you with us.

At this time I would like to recognize the distinguished ranking minority member of the committee, Mr. Winn, for any comments he may wish to make.

Mr. WINN. Thank you, Mr. Chairman. I, too, want to welcome Jack and Gordo to the committee hearings. I think both of them have been here several times, so this is not unusual, but you have not been here in the capacity in which you are here today. I want to congratulate you for a great flight, for accomplishing the additional experiments that are still a part of the research and development stage of our Space Shuttle. We welcome you. We welcome your wives.

It is amazing how, as the chairman says, we welcome you as new heroes, but it is amazing how you can pack a room with heroes, but when we talk about the budget, there is nobody there. Welcome.

Mr. FUQUA. Thank you, Mr. Winn.

Now I would like to recognize the chairman of the Subcommittee on Space Science and Applications, Mr. Flippo.

Mr. FLIPPO. Thank you, Mr. Chairman.

I just want to add my congratulations and to express my gratitude for the tremendous job that Mr. Beggs and you two gentlemen have accomplished. I join with the chairman, Mr. Winn, and other members of the committee, in welcoming you here.

Mr. FUQUA. Thank you, Mr. Flippo.

Now I would like to recognize the ranking minority member on the subcommittee, Mr. Hollenbeck.

Mr. HOLLENBECK. Thank you, Mr. Chairman.

I would like to join you and my colleagues in welcoming you two gentlemen here today and congratulating them and Jim Beggs on his leadership.

I look forward, gentlemen, to your insight on the STS–3 mission and, of course, it goes without saying that you are to be congratulated for accomplishing some very special specific mission objectives. Unlike the STS–2 mission, you had the extra day for sightseeing while waiting for the weather to clear.

STS–3 pushed the reusable *Columbia* orbiter further out into its performance envelope. Despite the failed wrist camera, the remote manipulator arm did work flawlessly in manipulating the plasma diagnostics package, which helped analyze the space environment immediately around the Shuttle.

By exploring various structural surfaces entirely to the Sun while the rest of *Columbia* remained in the shadow, the orbiter successfully endured environmental extremes more severe during the third flight than it is expected, I think, to encounter in operational service.

STS–3 also carried a variety of scientific payloads, including two materials-processing and two student-related experiments. The materials-processing tests helped prove the feasibility of zero-g manufacturing for chemical and biological products.

The Getaway Special, a 5-cubic-foot self-contained cannister, was flown in the Shuttle payload area to provide data for college stu-

dents who will use the cannister to house their experiments in future flights.

I think we all know that Jack and Gordon participated in the first student-shuttle-involvement program for secondary schools experiment, which involved letting different types of flying insects roam around inside a clear plexiglass container in the orbiter middeck.

I believe that the scientific and educational return from these student-developed payloads will be immeasurable.

By offering the so-called Getaway Special and the SSIP-S programs, we are providing more opportunities for our children to become interested and actively involved in the space program.

The members of the committee look forward today, gentlemen, to your testimony and you may look forward to our continued support for the space transportation system.

Thank you.

Mr. FUQUA. Thank you, Mr. Hollenbeck.

Mr. Dunn.

Mr. DUNN. Mr. Chairman, I also would like to offer my congratulations, particularly to Colonel Lousma, since he is from my home State of Michigan, and just to tell you one funny thing. I had the privilege of taking my family down there, and there was only one disappointing thing about the lift-off. My 2-year-old daughter wanted to know if she could see it again.

Mr. FUQUA. Maybe we will see that in a few minutes.

At this time I would like to recognize Mr. Beggs, and you may make any comments and present the group.

STATEMENT OF JAMES BEGGS, ADMINISTRATOR OF NASA

Mr. BEGGS. Thank you, Mr. Chairman and members of the committee. It is my pride and pleasure to bring these two distinguished astronauts to the committee today. I am very proud of them, as is the Agency. The Shuttle almost went as flawlessly in space as we are coming to expect.

Jack Lousma, as you know, is a colonel in the Marine Corps. He is a native of Michigan, he attended schools in Michigan, and went to the university there. He graduated from the university with a degree in aeronautical engineering. He also has been the recipient of a number of very prominent honors, including the NASA Distinguished Service Medal, and participated in the 1974 Robert J. Collier trophy award, which is one of the most prestigious in this profession. He and his wife, Gratia, have four children. I know from having talked with Gratia that she is a great supporter of Jack's endeavors.

Gordon Fullerton, as you know, is in the U.S. Air Force. He is a native of New York, graduated from high schools in Oregon, and then went to Cal-Tech, graduating with both a bachelor's and a master's degree in mechanical engineering. Gordo also has been very active in the Shuttle program, as you and a number of the other members have noted. He and his wife, Marie, have two children.

Mr. Chairman, President Theodore Roosevelt once remarked that the greatest prize in life is to be able to work at work worth doing.

We at NASA are very proud and pleased that we have been granted that privilege, and these two gentlemen, I am sure, are the latest in a long series of astronauts who have won that prize. To work at work worth doing and to do the kind of things we do in space, which in this country is done in an open manner so that everyone knows about it and can be a part of it, is really one of the greatest prizes in life.

I am proud to introduce these two gentlemen to the committee.

Mr. FUQUA. Thank you, Mr. Beggs.

Mr. Lousma.

STATEMENT OF COL. JACK ROBERT LOUSMA

Colonel LOUSMA. Thank you, Mr. Beggs.

Mr. Chairman, committee members, distinguished ladies, gentlemen, and visitors, it is truly a privilege and a pleasure for us to be here this morning with our wives to report on this most successful mission. It is always great to report on success.

We want to thank all of you at the outset for your support and for the decisions which you have made to make this mission possible. We also thank you for your prayers. I have said often that a few prayers will make up for a lot of mistraining. We had the prayers and support of not only all Americans, but people around the world. We are most appreciative of that.

I also want at the outset to reiterate that this was a team effort. It is a privilege for Gordo and I to have worked on this team. It took thousands of space workers, both within NASA and with contractors across our land, our neighbors from the north, the Canadians, and many others, to make the Shuttle work. It has just been a privilege and an honor for us to be involved and to be a part of doing what we like to do, but also doing something which we feel is significant and important for Americans and for people around the world.

This morning we would like to briefly summarize our mission. Mr. Hollenbeck just about stole our thunder, however, so we can be brief. Then, we would like to show you a film which we will narrate, and will answer any questions that we might be able to.

Bascially, this spacecraft was readied in only 4 months. The previous Shuttle took 7 months and the STS–4 will take only 3. So, we are turning around the spacecraft much faster than before.

We had an ontime launch, and this is something that we ought to advertise as well. Early in December, we knew that we were shooting for a March 22 launch date, but, we could have launched even earlier. That date carried through, and we were only an hour late getting off. We stayed an extra day just to make up for that. We enjoyed that, too.

The flight, of course, had an inclination of 38 degrees; that is, it went to 38 degrees north and south latitude during every revolution. We covered most, up to the midpart of the United States, over the Mediterranean, the southern part of the Soviet Union, China, and Japan, and so forth on the north.

On the south, we went as far as Australia, most of Africa, and most of South America; so we were able to cover a good deal of the

ground on the beautiful Earth on which we have the privilege to live.

The altitude was 150 statute miles of circular orbit. We orbited the Earth every 90 minutes of which 60 minutes was in the daytime and 30 minutes was in the darkness. The duration of our flight was planned to be 7 days; however, due to an extension, we stayed an extra day which was a real privilege. Our spacecraft could have stayed longer, though. We would have welcomed the privilege to spend 2 or 3 more days sightseeing, but the program was determined to have us land at White Sands the following day, or if need be, a revolution later to land at the Kennedy Space Center.

I think this also demonstrates the great flexibility in the Shuttle system to be able to change the landing site in the last week, and even while in orbit to decide within an hour or two that we are going to change the landing site. So, we have a flexible spacecraft as well as one that can get off on time. I think we demonstrated a real capability of this spacecraft on just the third flight that many people had been very skeptical of.

Our objectives, of course, were many fold and included the testing of the spacecraft and some of the scientific objectives that you have already stated.

Thank you.

STATEMENT OF COL. CHARLES G. FULLERTON

Colonel FULLERTON. it is a great privilege and honor to be in such distinguished surroundings and to tell you about the flight of STS–3. I hope I can share some of the feeling that a space rookie had on this flight. Jack had been there for 2 months on a previous mission. For me, everything was new, exciting and more thrilling than I had possibly imagined, and I hope I can pass a little of that along to you as we go on today.

I would like to emphasize that this mission was primarily a test of the Orbiter. This is the third in a series of four orbital flight missions. Our primary objective was to check out the airplane, so to speak, but we had a considerable array of scientific experiments onboard as well. During the times when we were cold soaking or hot soaking the Orbiter, we had the time to do a considerable amount of manned science. We will tell you more about that later.

I think one of the things we did was hit the photography end of it very hard on this mission. We took some 900 still pictures, 11 hours of videotape recordings, and we used all of the 16-millimeter film we had onboard. So, in order to get through all that this morning, we are going to have to get started right away.

Can we have the movie, please?

Mr. FUQUA. If we can have the lights down, we will roll the film.

[Thereupon, a movie was shown to the committee.]

Colonel LOUSMA. Here is our crew patch and Bob McCall, a well-known space artist, helped us design it.

There is a picture of the big bird sitting out on the launch pad the day before launch with the Vertical Assembly Building in the background. We were up about 5 a.m. to put launch escape suits on

and got into the little bread truck that was to take us out to the launch pad.

I asked Gordo to come around to the front to take just one last look at that big bird. We stood there gazing at it, awestruck almost, then we went up the ladder and across the gangplank. We helped the ground crew check out the spacecraft for a couple of hours and right at 11 o'clock e.s.t. the big bird lifted off.

Colonel FULLERTON. The space flight literally starts with a bang. When the main engine started, there was a certain amount of vibration. I was wondering, though, if the solids had lit off yet. When they did, there was no doubt. You have all the feel of a fantastic amount of horsepower going to work there and you have a very rapid acceleration. You are back in the seat and really moving out, without any doubt.

Colonel LOUSMA. We did a roll maneuver just before we went in to the clouds. This got us pointed downrange. This is how it looked from Gordo's side of the cockpit. You are laying on your back looking at the Atlantic Ocean and the beach, and, we are on our way. We went through the clouds just before the big bird started its roll. For those of you who are pilots, we got the BFR on top, as they say, very quickly. You can see the big bird starting to pitch over on its way back, on its way downrange.

There was tremendous vibration and tremendous power of acceleration, just a relentless push for 8½ minutes—a real speedy way to leave town, take the high road to New Mexico. The solid rocket boosters burned for about 2 minutes and then were jettisoned.

Colonel FULLERTON. Here we come out of the clouds. One of the chase aircraft took this picture as we made our exit from the last cloud we saw in the mission.

The first stage is certainly not uncomfortable. There is no problem reading the instruments or the checklists; however, there is a certain amount of vibration due to the dynamics of the situation. But, when the solids do burn out, after just over 2 minutes and are separated, the only indication of the separation, surprisingly to me, was a very bright flash. Here is an onboard camera showing the solid rocket booster being jettisoned. That flash is due to the separation rockets and that fire and their exhaust comes across all six forward windows.

Colonel LOUSMA. We accelerated to 3 G's on the Shuttle's main engines. At 8 minutes and 34 seconds, we had engine cutoff. Then the external tank was jettisoned. There is another onboard picture from underneath showing the big brown tank that carried hydrogen and oxygen being jettisoned. It continued on to the Indian Ocean. We would, too, if we had not burned our smaller engines to put us into the 150-mile orbit. When we got there, we had to get our payload bay doors open in order to get the cooling to cool off the spacecraft. These are being opened over the west coast.

You see a beautiful picture of Los Angeles, the Salton sea, the Imperial Valley and the Yuma, Ariz., area.

Then, we opened the other payload bay door. You can see the shiny surface which is the radiator. Up to this time, we had been rejecting heat by using our water boiler system. But, the water does not last forever, of course, so we need to get those radiators deployed to continue to cool the spacecraft.

On the right is the Canadian built, remotely controlled arm that Gordo was an expert in operating.

Colonel FULLERTON. Canada has its logo on the side.

We used that arm early on the second day when Jack noticed, out the forward windshield, that a couple of tiles were missing. So, we cranked up the arm and moved it to a more or less vertical position to utilize the camera that is mounted near the elbow joint of the arm to take this visual inspection of the nose area. Then, you can see again on this view some of the missing tiles appearing as dark patches in the area of normally white.

Colonel LOUSMA. We didn't worry significantly about that problem, however. We knew there was not much we could do about it and that we had the best minds in the world working on that problem, so we continued on about our business.

Here is a sweep through the payload bay to show you our experiments, the Office of Space Science package near the back and several other payloads that we carried into orbit on this flight.

We also noticed some venting from the aft area. I had seen something like this on Skylab, which turned out to be a propellant leak, so we were concerned about it. However, Mission Control identified this as just residual propellants from the main propellant system. This was venting off and lasted for 2 or 3 days.

Colonel FULLERTON. It made quite a show. Every time we got into a condition of dark sky with sunlight on the particles, we could see that.

Now we are starting more substantial arm tests. We started this test on the fourth day. It was the first time that the manipulator arm was used to grapple a payload which was the plasma diagnostic package, that cylindrical object with the sticks and balls protruding from it in various directions. The package is full of instruments to measure the electromagnetic effects to be found around the Orbiter's environment.

We used the arm in both manual and automatic modes, in both daytime and nighttime, and went through extensive all-day series on a couple long days of fully looking at the operation of the arm. I can say that the arm operation was absolutely an unqualified success. The Canadians should be truly proud of this very complex piece of machinery and how flawlessly it performed. In every instance, the operation of the arm was better than I had been led to believe from all the ground simulations and tests.

Colonel LOUSMA. In a couple instances, we actually maneuvered the arm out in front of the nose of the Orbiter.

Colonel FULLERTON. Finally, one of the biggest questions about the arm operation was in this very fine controlled required maneuver to bring the payload back and dock it in its mounting point in the payload bay. We are just bringing it down as we cross the Baja Peninsula south of California and Mexico. Here the plasma diagnostic package has been berthed. There is only about a 2- or 3-inch clearance aft and to the left of it, between it and the other instruments.

I found, though, that you could control it within a half an inch of where you wanted without any problem. It was just a pleasure to work. After each day's activities with the arm, we cradled the arm in its mounting provisions along the port side of the payload bay,

as shown here. Those mounting stanchions are rotated inboard when not in use so that in case the doors need to be closed quickly, they can be.

Colonel LOUSMA. One of the things that all of you would enjoy about being in space is the ability to move around with ease. If you want to, you can take the headfirst approach down the hole into the lower deck. We had a flight deck above about the size of a 747 cockpit, I guess you might say, and down below was our living area. In these lockers, we stowed all our extra clothes, food, magnetic tape films, spare parts, and so forth.

Colonel FULLERTON. Here is Jack with the feetfirst method.

Colonel LOUSMA. Yes, if you want to go feetfirst, you can do that, too. But, you can see, you can be anywhere there in a flash, much easier than anywhere else.

We also had a number of experiments in the cabin that we were monitoring and working with. This one happens to be a plant growth unit. We would read the temperatures in this plant growth unit three times a day to make sure that it was right. Of course, if you don't want to set things down up there, you just let them float and pick them up on your way.

Colonel FULLERTON. If this looks like fun, I can assure you, it's ten times more fun than it looks like it is.

Here I am processing one of the samples from our electrophoresis experiment. This experiment utilizes an electric field to separate samples which has a certain pharmaceutical use and is a precursor to what may be a much more extensive processing on not only the next mission, but downstream as a regular sort of thing.

Hygiene was important. Jack is cleaning up here for the daily TV show.

Colonel LOUSMA. We had a little overnight kit to use. We had cold, running water and soap and could brush our teeth and shave.

Do you want to move that, Gordo? It's in the way. Attaboy. See, you can really be casual about hanging your clothes and so forth up there. Gordo got his hairbrush out. I didn't recognize that instrument.

Colonel FULLERTON. Chow time was a great pleasure. After the first couple days, we got our appetites back. I was being very careful at first not to spill anything. Then I found out it was fun to spill something. You let it go, just give it a tap with your spoon or reach out and grab it with your mouth. My kids would have really liked this.

Colonel LOUSMA. You can stand on your head and eat, if you wish. There is no way to spill your milk and you can't knock anything off the table. So, for all the kids here there is no way to get into trouble with Mom up there. Most of our food was mixed with water and we had a heater that we could heat it up with if we so desired.

Colonel FULLERTON. We took the exercise regimen very seriously. Here I am running along, taking a 10-minute run on a prototype treadmill. During that 10 minutes, we covered 3,000 miles.

Colonel LOUSMA. The treadmill was designed and developed by one of the medical astronauts. Of course, when you push on that you are going to rise, so we had pungies that held us down. When we pushed with the pungies, it held us back down on the treadmill.

You can actually work up your heart rate quite high and get some good exercise. Of course, it is very important to exercise regularly when you are in space because your body does not do any work unless you force it to. In fact, you do less work there than you do at home sleeping in one gravity because there is just no force on the heart at all. So, we have to do a lot of exercise in order to maintain our body condition. Of course, we not only wanted to exercise our legs, but other parts of our bodies as well. Gordo improvised in doing some chinups. He is straining away here. I did not know if he was going to make it through these or not. Of course, we did not find it too tough up there, and we even had a little weight-lifting and balancing act.

We did a few stunts to show how it is to be weightless. Not many folks can do this. You say he puts his pants on one leg at a time like everybody else, but you are mistaken.

Colonel FULLERTON. After I get this down, I plan to get a Dorothy Hamill wig and try out for the Ice Follies.

Colonel LOUSMA. Of course, marines have to do their pushups every day, so being in space was no exception. After a while if your arms get tired, you can just do it with one arm, or you can do footups if you wish.

Colonel FULLERTON. After too many commands from the ground, this is an antifrustration maneuver here.

Colonel LOUSMA. It finally came time to come home. So, we lowered the radiators and closed the big bay doors for our re-entry to the Earth's atmosphere. We were waved off the first day and had a 1-day vacation. Finally, on the second day we were cleared to come into White Sands, with Kennedy Space Center as our backup.

These are some pictures that were taken a long way out. We flew the vehicle intermittently manually during the descent, and finally took it over at Mach-1. we flew it manually down to about 11,000 feet where we gave it over to the automatic system to control.

Just as the ascent was a relentless powerful shove, I had the feeling that the descent was just a relentless deceleration, like the big craft was digging in its heels for 20 or 30 minutes, slowing down from 25 times the speed of sound to zero on the end of the runway. We had a beautiful day out at White Sands after that sand storm the day before. Many of you were there and we appreciate your being able to stick with it. I understand it was a real survival course out there.

Colonel FULLERTON. This picture was taken from a camera mounted by my right shoulder looking forward, and we are making a right turn off of the base leg. We were on our final approach. There is White Sands coming into view, and then at the far right of the picture as we turn, a white streak which is the lead in mark to the runway we were aiming for. We had a strong right crosswind at that altitude which actually stayed pretty strong down to low altitude. As Jack engaged the automatic system at this point, we were flying hands off all the way down final approach at a 19° angle to ground, the auto system was grabbing the airplane to the right to compensate for that wind. As we get closer, you will now see the triangle or aim points that we are heading toward. Actually, our aim point was that rectangular black mark.

The automatic system made what we call preflare, or pulling out of the dive. Then, as we decelerate and head toward the touchdown point, at about 150 feet in the air, Jack took manual control to complete the landing.

Colonel LOUSMA. This is an accelerated picture of the rollout. We got the nose down and up and down again and did a nose wheel steering test on the end of the runway. Here is a final picture of the approach. We took over manual control at 140 feet and got the wheels down. We were a little lower than we had been in the past due to the automatic system. Everybody thought we were delayed in getting the wheels down but we made a reasonably good touchdown. The nose started to drop as we rolled out. We did not want the nose to get on the ground at this speed so I attempted to raise it. I performed a maneuver that had never been done before, popped a little wheelie there, but no damage done. We rolled out, did the nose wheel steering test at 50 knots with almost no braking. We could have stopped much sooner. However, we saw the end down there and realized that we had plenty of room to roll, so we just let it roll out. This was a real operation and took a lot of coordination to be able to land at White Sands, and, so many people put so much into it in a short period of time. It is a real tribute to their capability.

We stayed in the spacecraft for about 30 minutes helping to secure it. When we got out and walked down the ladder, we held on to the railing so as not to fall on national TV because we were a little clumsy on our feet for a day or two. But, both the big bird and we were in good shape.

We were glad to see everybody and to have been part of such a successful mission.

[Whereupon, the movie was concluded.]

Colonel FULLERTON. I would like to quickly summarize some of the results. One of the biggest tests on the orbiter was the result of the extreme thermal attitudes we held. We found that in every case the effect of being very hot or very cold, as we were in both instances, was not as traumatic to the orbiter systems as had been predicted by the engineers. All the fluid systems maintained their proper temperature and were fully operational. We tested the orbital maneuvering engines as well as the attitude control engines under extreme thermal conditions, and they performed flawlessly.

One of the concerns was distortion of the structure, whether the payload bay doors would close properly or whether the payload bay doors would distort and disturb the very fine pointing required by some of our scientific instruments. In every case save one very brief instance, the payload bay doors closed beautifully, with almost no distortion whatsoever. The one case where we had a jam of one set of the latches was solved within 15 minutes by just changing the attitude to warm up a set of seals.

The launch successfully provided a more demanding launch environment, and we learned that the aerodynamic surprises that existed in the first two missions have been now fully understood. Essentially, we flew right up to predicted line during launch. We did some additional maneuvers during entry to expand our knowledge of the aerodynamics during that regime.

We were concerned about power usage. But, we found that we were able to power down at nighttime to a very low power level, only 10 kilowatts for that entire vehicle which resulted in our having enough since the use of consumables to generate that power was much less than expected. Hydrogen was a limiting consumable to fly our extra day plus three more had we needed to.

Colonel LOUSMA. Scientifically, we determined that the Shuttle is a better space platform for further scientific investigation than we had first thought. It has a very low electromagnetic interference environment; very small electric field around it; smaller electric charge on it than we had expected; minimum interference as it plows and makes a wake through the thin atmosphere up there. The pressure and the concentration of the contaminants and particles carried along with the Shuttle is also much lower than expected. In addition, the optical qualities of the cloud are better than we had expected as well. Basically, we can say that we have determined from the experience that we had on board that the Shuttle is a much cleaner environment in which to do scientific investigation from than we had expected.

All the cabin experiments worked very well. The plant growth unit and the others which were more medically or pharmaceutically related also worked very well and show promise for more expansive use for commercial users and for research groups for the future.

Colonel FULLERTON. I would like to close my part of the program with some thoughts that occurred to me both during the flight and after. One of the things that surprised me was that continually during the flight there was a building feeling, and that was the evidence of speed. You have all flown on airliners, and if you look out the window, you have to look closely to make sure you are moving. Airplanes at altitude look like they are suspended there. Such is not the case in the orbiter. Our oribtal velocity was some 18,000 miles an hour which is 5 miles per second across the ground. Every time I looked out the window, especially after I had been there a couple of days and had a feeling of scope of what I was looking at, and how fast it was moving by, I became more and more amazed. To relate, from the time we coasted in at San Francisco until we left New York was about 10 minutes, so you are really moving out all the time.

Looking down at the Earth is a fascinating thing. I could easily have spent the entire 8 days just looking out the window. You see that much of the land that makes up this Earth. There really is no sign from that altitude of man being down there, even in the areas where you know there are millions of people. For instance, we flew across India in one pass, and had a chance to look at the country from side to side. I knew that there were some 680 million people down there, but very little evidence from that far away, 150 miles where I was, of any of them. That somehow seemed incongruous to me that we are in this unbelievably advanced technology, benefiting from being aboard a product of that technology, and we are looking down where people are fighting and many people are starving or at a bare subsistence level. Somehow, it is hard to figure. It brought home the point to me that we have to do a lot better job in

utilizing this technology to the utmost to find the long-term solution to all those problems that we were flying over.

Colonel LOUSMA. I agree with Gordo in that respect. I think the concept of "Spacecraft Earth," has been one which has been used many times. But, as a result, reflecting on my Skylab flight and also this one, it is clear that we were looking at a world that is just the way God made it, without those boundaries that we see on the globes and maps that we have in our homes and schools. Philosophically, we hope for the time when people will relate to one another emotionally without those boundaries, and just in the same way that we were physically looking at the Earth from space.

As Gordo pointed out, the perspective of being able to travel over this whole world in just 1½ hours and recognize that with this great technology that we have, the great privilege that we have of living in this country where we can do these kinds of things that are still a great ambiguity in a world where, as he mentioned, people are really starving or are without medical attention, and certainly are not getting along very well. And, we seem to get along worse all the time. We are just going to have to learn from this spacecraft we are living on to use our resources more effectively and more efficiently. We are going to have to get along better as the crew, or there is not going to be a successful flight for any of us. That is not to say that we should not be continuing to do these things; but, I am just pointing out that there is an ambiguity there. We do take our efforts here in America for granted. We need to realize what a privilege it is to live in this country and to enjoy all the things that we every day fail to really appreciate in the way that we should.

I think, as we have an opportunity to see the world in a way that nobody elese has; therefore, we do get some insight and perspectives that are important to convey to people. We wanted to do that to you.

While we are talking about America, it is just incredible the way that Americans have responded to the flight of *Columbia*. I do not think we were prepared for the enthusiastic support that we have received as a result of these flights. For example, there were more people at this launch than have ever been before. There has been recognition by the media that this is not a routine program; and the media are going to have to support it by responsibly reporting to the American people the things that they want to hear about. So, there is a great deal more media support than we had anticipated; more people enthusiastically weathering the desert storm than we had thought possible. In essence, I think we are seeing a response from the American people that is just more favorable and more enthusiastic than we had ever thought before.

There are more requests than we can possibly handle to come and talk to people. There is just more enthusiasm than we had expected everywhere we go. It seems to me that there is a real change in the American climate with respect to the space program and the flight of the *Columbia*. I think the reason is that, after more than a decade or so of Americans whipping themselves for what they have done in the past in front of the whole world, we are finally recreating a climate in which we are openly expressing what we have really always felt but have failed to promote—that it

is great to be an American. I believe all of us share that sentiment; and, I think, it is about time that we advertise it more widely and more enthusiastically than we have in the past. Americans are ready to do that and it is gratifying to see the spirit of patriotism, pride in achievement, and pride in America rekindled again. Americans are finally getting ready to assert themselves more publicly in the role of leadership in the world community of nations. I think we are saying, "We are good. The *Columbia* is clear evidence that we are as good as we thought we were, and it is a clear demonstration to the whole world that we are."

Americans are grasping at the Shuttle as a tangible symbol of American achievement and American pride. Of course, the *Columbia* is an opportunity to fly our colors around the world every time we fly. It is an opportunity for us to demonstrate our national will and our national resolve to be "No. 1." It is a real privilege for us just to be part of that program, but I believe Americans are identifying with the *Columbia* as being their spacecraft, and the *Columbia* flights as being their flights rather than just something that is put on by the Government. I think it is important for us to realize that as we make decisions and move forward, we would be remiss if we did not honor this enthusiasm with the appropriate response.

In closing, we just want to indicate to you that we are proud to have been part of this program; proud to have been part of this team, and proud to be doing something which we feel is good for this country at a crucial time in its evolution, and we need to continue. Again, we want to thank you for your prayers and for your support as well as the prayers and support of people across the country and around the world. Truly, this is America's flight, and we are proud to have been part of it. Thank you very much.

Mr. FUQUA. Thank you very much, Jack and Gordo. We are all very proud of the accomplishments that you have made, and of a very successful flight.

Jack, I think you mentioned thanking the people, the contractors, the NASA people, and I just want to deviate from the norm we usually have here to say a get well to a guy that helped you guys get off on time, George Page. I understand he is doing well, and we wish him a speedy recovery, and get him back to STS 4 and 5 and 6 and 7 and 8. George, for those who may not be aware, is director of launch operations at Kennedy, and just underwent open heart surgery. I understand he is doing well, and we wish him a speedy recovery and best wishes to his family. He joins the "Flippo Zipper Club." We are very pleased and proud.

I just have one question. In the automatic landing, you took over right at, almost at the last few seconds before touchdown. What are your thoughts about future flights, maybe that that be done at 2,000 or 3,000 feet so that you have a chance to respond to the vehicle before it lands?

Colonel LOUSMA. That is a very good question and an excellent observation. Gordo pointed out this was a test flight. One of the things we were trying to test is the automatic landing system. However, we were trying to sneak up on it in a stepwise manner. The flight before had, of course, not flown quite this low. The automatic system on flights in the future will actually make the landing. However, our plan and requirement was to take over just

before it landed and manually land it, allowing the automatic landing system to land some future flight.

However, when you take over a machine that is 110 tons, moving 300 miles an hour across ground, 140 feet above the ground, you know you have a locomotive by the tail. What we demonstrated, was that, if in the future, when we are doing automatic landings, we were required to take over landing, we cound safely do so. However, we prefer not to do it. I think the recommendation that is coming out of this flight is that we either let it land automatically all the way, or take it over at 2,000 or 3,000 feet to allow the pilot to fly it to a position in the sky in which he feels comfortable. However, all of the data is still being carefully analyzed. Decisions will be coming out on that kind of recommendation in addition to some others. I am confident the next flight will make a responsible decision to either land automatically or take it over sooner.

My colleagues have reminded me that I failed to do one thing that I should have done. I have a presentation I would like to give to you, Mr. Chairman, Mr. Flippo, and Mr. Winn, particularly. Of course, we have enjoyed your informal attendance at the dinner the night before launch on several occasions, and we look forward to that opportunity again. We appreciate not only your official, but also your unofficial friendly hospitality on many occasions. On behalf of NASA, Gordo and myself, we would like to make this presentation to you and the committee. We have a framed picture that has an American flag which was flown on the *Columbia*, and it says, "This flag and crew patch were flown aboard the third flight of the Space Shuttle *Columbia* as it completed 130 revolutions of the Earth and it traveled 3.4 million miles the last week in March of 1982. It is given in recognition of your continuing support of our Nation's Space Shuttle Transportation System."

It also has a few pictures of this particular flight. We have the launch showing the unique brown tank, the first of its type and one of our favorite colors; the landing out at the most scenic area, the White Sands Missile Range, and a picture while in orbit operating the arm with the payload.

Mr. FUQUA. It is White Sands Space Harbor now.

Colonel LOUSMA. We would like you to have this as a memento of our appreciation for your support.

Mr. FUQUA. Thank you very much. I just want to commend Gordo for doing a very superb job with the remote manipulator with the camera being on the blink, and having to improvise. I think you did a very outstanding job, and we are all proud that the mission was able to be such a success. Certainly, your efforts and long hours of training have certainly paid off. We congratulate you for that.

Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

You mentioned when you came off the shuttle down the steps, you had to hold on, or thought it was wise to hold on so you would not fall before national television. You said you were shaky on your legs. What is the effect that causes you to be shaky, lack of exercise, or lack of standing solidly on your legs? What effect is that?

Colonel FULLERTON. To me, the shakiness was not a matter of feeling heavy so much, although I felt heavier than I had before we left, it was a matter of our equilibrium rather than strength. You do not get much of a workout when you are just floating around and have no need to balance yourself. That balancing ability goes away. Jack and I both found that it took about a day or two to feel like we could walk a perfectly straight line and not bump into door jambs if we were not watching real close.

Colonel LOUSMA. Unfortunately, we did not get to use the exerciser as much as we would like to have done. I recall after our Skylab flight, the recommendation was that each crew man get an hour and a half exercise per day. We were not able to do that. We also found in Skylab that there are some sensors in your leg muscles that get lazy when they are not stimulated in a lateral motion. We devised a means by which to solve that, but I think we were experiencing some of the same feeling because it was a similar phenomenon, as I recognize it. It lasted for 5 days after our Skylab flight; however, it was a much shorter duration phenomenon this time.

I think we do have ways to cope with that, but we just were not able to completely take advantage of them due to the time spent doing all the experiments, and so forth. We find in space that the things that suffer the most and the things you need to do the most—is to eat on time, sleep on time, and exercise regularly. I think we can, however, solve that problem in the future by giving attention to it.

Mr. WINN. What recommendations are you making to NASA for the next flight that they should incorporate into their flight plans?

Colonel LOUSMA. We actually made 30 recommendations.

Mr. WINN. What are some of the main ones?

Colonel LOUSMA. One, of course, was not to take over the spacecraft 140 feet off the ground which was mentioned earlier. We had a number of mechanical things that we ought to fix that were more of a minor detail nature than anything else. Gordo, do you remember any of the others?

Colonel FULLERTON. We had a problem with one of the auxiliary power units that provides hydraulic pressure on launch, and that is becoming a regular thing. We have had a problem now on three flights, and we definitely want to understand that better.

Mr. WINN. Is that a backup system to start with?

Colonel FULLERTON. We have three of them. It is definitely not a backup system. You have got to have at least one to successfully complete a launch or a landing, so the name "auxiliary" power unit is a misnomer. It is really a primary hydraulic power unit.

The other two units performed fine with no problem, and we hit our insertion right on. That same unit worked fine, so we had all three working for landing, but what is going on during launch is something we need to understand.

We had many little things. Someone asked me recently, "What didn't you do on your flight that is going to change or affect the planning of the next flight, STS-4?" There is not anything. We got right to all the squares and filled them all. STS-4 is proceeding with the flight plan they had before we flew.

Colonel LOUSMA. We had several recommendations with respect to flight planning in the future which was not to make the first day or two too rigorous on account of the motion sensitivity problem. One thing that we did for 3 weeks before the flight was a lot of acrobatics in airplanes to desensitize ourselves. We thought that this got us through that time period more quickly and with less discomfort. Actually, after we got back and read the clippings about the flight, we were surprised to learn that all of the things that gave us minor problems were magnified on the ground. They were more of a nuisance-type item to us. I guess it was hard to find something really to write about on this flight; and, therefore, the little problems became much bigger on the ground than they were in flight. As Gordo said, as far as we are concerned, we filled all the squares and did everything, and I think that we can be proud of the vehicle we have got and the team we have, and we are getting that all done. But, motion sensitivity, physical discomfort, and that sort of thing, although it was minimal, it is something that we need to compensate for in the future. One of our recommendations was along those lines.

Mr. WINN. Jack, what was going through your mind when you were talking about the possible alternate sites, landing sites, including the cape? I know that this does not just come out of the clear blue to you; this is discussed with NASA officials and those on the ground at the various sites, but tell me about the landing, about the strip down there where you might have had to land. How long is it? How wide is it compared to Edwards or to White Sands? I am trying to get a comparison about your potential for landing.

Colonel LOUSMA. The concrete runway, we have at the cape, is 300 feet wide by 15,000 feet long.

Mr. WINN. What is the length of a normal airport, 10,000 or 11,000 feet?

Colonel LOUSMA. Most commercial airports are 10 or 12,000 feet. The lake bed runway we landed on was marked out to be 15,000 feet and 300 feet wide, so we were landing on a marked-out runway which is identical to the hard surface runway. Although we had an overrun at each end of some 8,000 to 9,000 feet, we did not have to use it. As far as the feeling about landing at one place or another was concerned, Dr. Kraft and Dr. Lunney, along with John Young and Mr. Abbey, met with Gordo and I when the decision was being made to land at White Sands. We pointed out that most of our practice had been done at White Sands, but we would be just as comfortable landing there as at Edwards Air Force Base. They asked about the backup site being the Kennedy Space Center with a hard runway down there, and we felt equally comfortable with that. We had practiced on that many times with our shuttle training airplane. As a matter of fact, the day before launch we both had very successful training periods on it. When the word came up that there was a possibility that we might, in fact, land at Kennedy Space Center, I treated it just as another runway on which to land with no reservations whatsoever. I think we could have gone there as a backup just as well as not. However, I still think we ought to proceed with the conservative approach. Our pilots like to have all the runway we can until we really nail down the landing characteristics as specifics on the bird. I think we ought to continue to go

for the lake bed, but still and all the Kennedy Space Center runway could be used if required.

Mr. WINN. I wanted to being that out, because there are some people that still feel that there is an increased element of danger to your lives or to the lives of the astronauts by selecting an alternate site. I do not think that they are aware of the many hours of training and the discussions with the entire team that you have based on the fact that you have two alternate sites. There are three possible places in which you can land.

I think that some of the newspaper and TV articles that I saw and heard sort of gave the people the idea that it is extremely dangerous to land at White Sands or the cape. I am glad that you brought that out that it does not really bother you, it does not really affect you very much one way or the other, because it is an alternate plan that you have built in.

I was pleased, too, to see NASA bring I think, what was it, Pat, there were 32 or 33 ambassadors, from various countries; is that right?

Mr. PAT TEMPLETON. There were about 40.

Mr. WINN. On Shuttle 2, I heard the story that some businessman went to, I think it was South America and heard a teacher tell her class that in America this was just a gimmicky thing, that there was no such thing as a real Shuttle shot, that this was just some kind of an exhibition like a TV show or something that the Americans were putting on. This same man supposedly, as I heard the story, flew or was going to fly that whole classroom of students up to the cape so that they could see that launch; is that correct?

Colonel LOUSMA. That is correct.

Mr. WINN. I think the fact that had the ambassadors there and those ambassadors being the spokesman for their countries, certainly could hear and see it themselves, and that is a good PR move, because I am afraid there are people in the country who still think that this is some kind of a promotional gimmick put on by the United States and that you guys are not actually going around.

I am sure the Russians know that it is not a gimmick, because they are concerned about what you are doing when you are going over their country.

I am also glad to see that it is not old hat. I do not think it is old hat to the members of this committee who have been working on it for years and certainly not to the chairman and myself and I do not think it is, by the size of this crowd.

I think the people in the country have a much better understanding now of what you are trying to accomplish and what we are accomplishing by the Shuttle program. As expensive as it is, I have yet to get a piece of mail from my congressional district or anywhere else in the country asking me to vote against the Shuttle program.

Thank you very much and congratulations again. Thank you, Mr. Chairman.

Mr. FUQUA. Thank you, Mr. Winn.

Mr. Flippo.

Mr. FLIPPO. I guess I was impressed by your comments as you were flying over and looking down at this planet and knowing the

problems that exist in India and the United States and many other areas and what part the space program was playing in that.

It reminded me of the early English economist named Malthus, who suggested that the natural state of man was at the subsistance level. That gentleman probably would have been correct, except for advancements in science and technology. Through those advancements, we have been able to improve the standard of living of many people on Earth.

I am sure that it crossed your mind as you looked down that there is no solution to those problems on Earth that does not involve advances in science and technology, that pushes back the frontiers of those problems and helps us understand our environment and the world we live in a lot better.

I know that it must have been a great feeling of pride that you felt because of your contribution in pushing back those frontiers and helping people to live better.

The growth industries in the world today in aeronautics and in communication and computers and electronics and in many other areas, the contribution of NASA and the other research and development programs that have provided the focus, if not the actual development, has been immeasurable, the contribution that has been made. You can never measure the improvements that it has made in the lives on earth.

I commend you gentlemen for your tremendous contribution to continuing the effort to push back those frontiers and deal with human problems.

Thank you, Mr. Chairman.

Mr. FUQUA. Thank you, Mr. Flippo.

Mr. Young.

Mr. YOUNG. No questions, thank you.

Mr. FUQUA. I think if there has been one universal message that I have received in the 20 years that I have been on this committee and working with men that flew in the Mercury and Gemini and Apollo and Skylab and the Space Shuttle, I think you summed it up that most of the men that have flown have come back with that message that, you don't see the artificial lines that exist on maps and globes. We do live in one great big space ship, Earth, and hopefully we can devote more of our efforts to try to improve life here and you are helping to contribute to that and playing a vital role in that. We congratulate you and thank you so much for sharing your time and that of your families.

Mr. HALL. Mr. Chairman, I noticed in the showing that as you pulled the nose up, that it seemed like it paid off, just like that came right back down. Was that intended or was that just a reaction, or did I just see something that I think I saw and that I did not.

Colonel LOUSMA. No; you saw that, Congressman Hall. I did that. I will take the hit for it.

Actually, the nose was coming down prematurely. We don't want the nose to be on the ground at that speed, so I was trying to raise it again. My first input did not do much. The second input when it went in, it was about time for the first one to catch up with it; so it over-rotated just a little bit. I tried to fly it back down and about that time it was time for it to come on the ground, so it did. That

was a pilot input; however, I just learned yesterday from an analysis of the data, that it appears that we can do something to improve the longitudinal characteristics of the control system while the vehicle is on the ground. They were telling me not to take 100 percent of that, so I am not going to; but, I think, we learned something. In the past, it has just been the pilot's requirement to lower the nose to the ground. We had not seen that and no one has ever tried to raise the nose or fly it a little more while it is on the ground.

Mr. HALL. Well, I guess that is why it is called an experimental flight.

Colonel LOUSMA. I think we learned something that is going to be valuable for the future by doing so. It remains to be seen exactly what kind of changes we do make, if any; but that is the latest I have on it. We would be pleased to keep you informed as new elements come our way, if you so desire.

Mr. HALL. You were right at the critical stall speed there at the time, right?

Colonel LOUSMA. No, sir, we did not have flying speed any more, but the nose was able to continue to remain in the air at that time and should have. When we got it down, it was time for it to come down, but it was below the flying speed of the aircraft. We did not come off the ground, just the nose wheel raised a little unpredictably there.

Mr. HALL. Thank you, Mr. Chairman, and thank you and your two lovely wives for your appearance here today.

Colonel LOUSMA. Thank you, sir.

Mr. FUQUA. thank you very much. We appreciate your taking your time and sharing it with us today and look forward to when announcements are made that you have another flight going back. Thank you very much.

The meeting is adjourned.

[Whereupon at 11:30 a.m., the committee was adjourned.]

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